NASA-CR-193799

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2P

NASA FINAL PROJECT REPORT
P.I.: Vahé Petrosian
NASA Grant ____

SUMMARY OF COMPLETED PROJECT

The primary goal of the work in this proposal has been the determination of the requirement for acceleration of particles, especially electrons during solar flares. This is one of the important and yet unsolved problems in solar flares and other astronomical objects. This is done by detailed theoretical investigation of interaction of accelerated particles with ambient plasma including interaction with particles, waves and large scale magnetic fields. Comparison with observed impulsive phase radiation such as X-rays, gamma-rays, miocrowaves and type III radiation is used for constraining the models and for determination of the characteristics of the accelerated particles.

Steady state and time-dependent numerical codes have been developed based on the Fokker-Planck method for study of the particle acceleration and transport during a flare. Using these, the correlation between characteristics of radiation at various wavelengths have been investigated and some constraints have been set on the model parameters.

During the last three year period of this grant, dissertation research of three graduate students have been partially supported by this grant. Each of these theses has dealt with various observed properties of flare emission with particular emphasis on the interrelationship between radiation in at least two energy bands: X-rays and gamma-rays, X-rays and microwaves, and X-rays and type III radiation. This has allowed considerable tightening of constraints on models, and inclusion of wave particle interaction has allowed direct calculations of acceleration processes.

This work will be continued with further comparison with old and new observations as they become available during the next solar maximum, and with the goal of obtaining more realistic models and furthering our understanding of the acceleration process.

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PUBLICATIONS RELATED TO THIS PROPOSAL

A. Published Papers

1. Hamilton, R.J. and Petrosian, V. *Generation of Plasma Waves by Thick Target Electron Beams and the Expected Radiation Signature*, *Ap.J.* **321**, 721, 1987.
2. Lu, E. T. and Petrosian, V. *Rapid Temporal Evolution of Radiation from Nonthermal Electrons in Solar Flares*, *Ap.J.* **327**, 405. 1988.
3. Lu, E.T. and Petrosian, V. *The Ratio of Microwaves to X-rays in Solar Flares: The Case for the Thick Target Model*, *Ap.J.* **338**, 1122, 1989.
4. Hamilton, R.J., Lu, E.T. and Petrosian, V. *Numerical Solution of the Time Dependent Kinetic Equation for Electrons in Magnetized Plasma*, *Ap.J.* **354**, 726, 1990.

5 Lu, E.T. and Petrosian, V. *The Relative Timing of Microwaves and X-rays from Solar Flares*, *Ap.J.*, **354**, 735, 1990.

6. Hamilton, R.J. and Petrosian, V. *Statistical Study of the Correlation of Hard X-ray and Type III Radio Bursts in Solar Flares*, *Ap.J.*, **358**, 644, 1990.
7. McTiernan, J. M. and Petrosian, V. *The Behavior of Beams of Relativistic Non-thermal Electrons Under the Influence of Collisions and Radiative Losses*, *Ap.J.*, **359**, 524, 1990.
8. McTiernan, J.M. and Petrosian, V. *The Hard X-ray and Gamma-rays from Solar Flares*, *Ap.J.*, **359**, 541, 1990.
9. Hamilton, R.J. and Petrosian, V. *Effects of Coulomb Collisions on Cyclotron Maser and Plasma Wave Growth in Magnetic Loops*, *Ap.J.*, **365**, 778, 1990.

B. Papers in press

1. McTiernan, J.M. and Petrosian, V. *Center to Limb Variations of Characteristics of Solar Flare Hard X-ray and Gamma-Ray Emission*, *Ap.J.* in press.

C. Papers presented at scientific meetings

About ten papers at various AAS and SPD meetings during the past 3 years, contribution to Max '91 Workshop Proceedings and invited contributions at the following workshops and symposia.

1. Petrosian, V. 2nd Workshop on Impulsive Solar Flares, Univ. of New Hampshire, 1988.
2. Petrosian, V. Solar Flare Workshop, Goddard Space Flight Center, 1988.
3. Petrosian, V. IAU Symp.142, Basic Plasma Processes on the Sun, Bangalore,India. (Contribution to Proceedings only).
4. Petrosian, V. Flares 22 Workshop, "Dynamics of Solar Flares", Chantilly, France, 1990.

E. Ph.D. Theses

1. McTiernan, J.M., *Numerical Simulations of X-rays and Gamma-Rays from Solar Flares.*
2. Lu, E.T., *The Evolution of Energetic Particles and the Emitted Radiation in Solar Flares.*
3. Hamilton, R.J. *Coherent Emission and Stochastic Acceleration Processes Associated with Nonthermal Electrons in Astrophysical Plasma.*